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# TO TILT OR NOT TO TILT

*British Railways APT-P set No. 370 006 at Stafford on October 3, 1980, when it made its first "press run" from Euston to Stafford and back. Photo: John Slater*

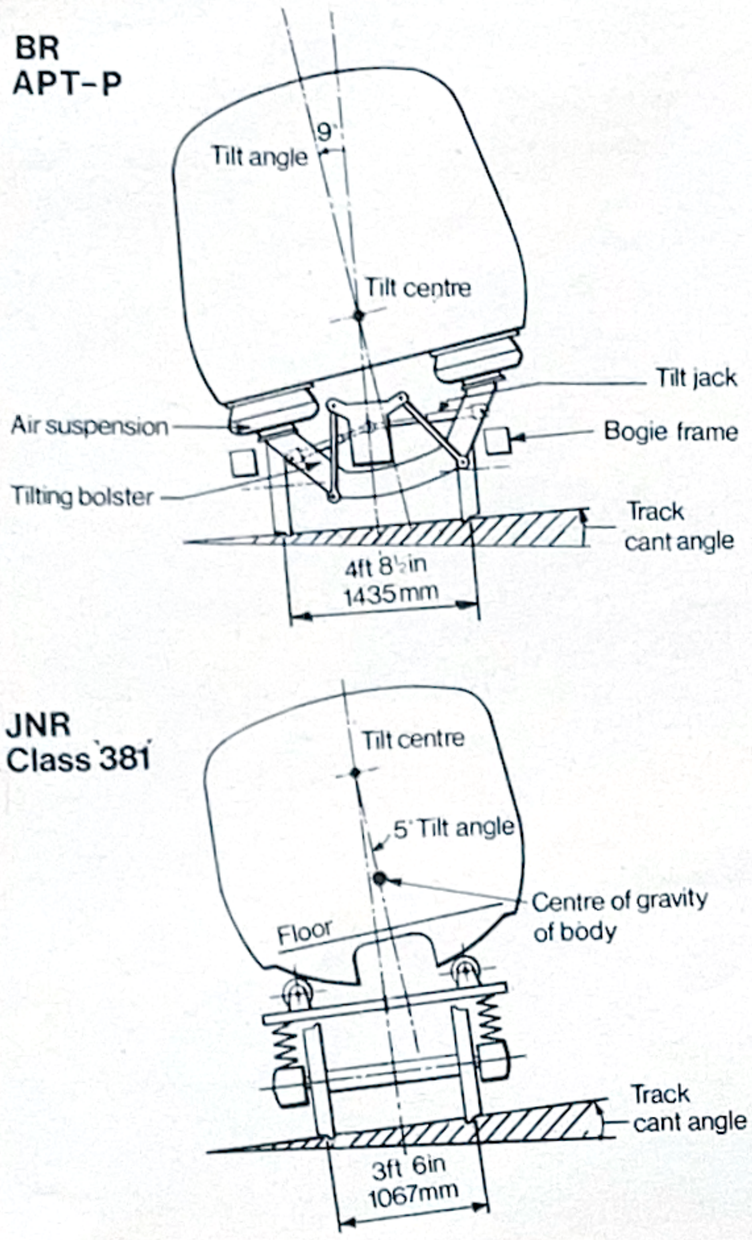
THIS article is due to appear within a few days of the first anniversary of the public debut of "APT-P". I had thought therefore it would be an appropriate time to comment on subsequent developments, especially as, during my recent Japanese visit in the summer, I was able to ride in the cab of one of their *third batch* of tilting e.m.us. Then, just before I put pen to paper, there came the announcement that priority was going to be given to the development of the production trains, "APT-U", rather than the "APT-P", which made it more important than ever to try and provide some sort of review of the project. I must emphasise that the comments are entirely my own, based in part on my own experience of technological development in industry, and without any particular "inside" knowledge.

As we discussed last month, the Japanese "Bullet Trains" showed it was possible to sell speed and at the same time operate a safe service at 130 m.p.h. using what amounted to existing technology, albeit combined in a unique fashion. However, it did require the building of a completely new railway, and I must again remind readers what happened in the way of public reaction in this country when it was proposed to build a Berne-gauge line to connect the Channel Tunnel with London. While the coastal areas of Japan are not dissimilar to this country when it comes to population density, there has been quite a reaction to the concrete "intrusion" of the Shinkansen, as there has been with motorways in this country too. Some of our lines are sufficiently free from curvature and other restrictions to permit high-speed running over long distances using conventional equipment, but others unfortunately, are not. It was precisely to overcome this problem that the Railway Technical Centre developed the APT.

However, before discussing this particular solution we must consider the constraints imposed by simple physical laws, because these are fundamental to any solution to the problem. The first basic law of motion taught to me when I was at school was that a body would remain at rest or in uniform motion in a *straight line* unless it was acted on by an external force. Getting round curves at high speeds is all about such forces. It might be thought that the flanges of a railway wheel riding on a steel rail provided the perfect way of providing these, but the squeals of protest as flanges grind their way round sharp curves at low speeds in freight yards is sufficient reminder that this is not achieved without added friction and consequent wear.

It is, however, possible to get gravity to provide the turning force required, by canting the track. As a vehicle goes round super-elevated track, there is a component of the reaction between the rail and the wheel tread which provides the necessary force towards the centre of the curve, thus avoiding the need for the flanges to be called into play. However, any such curve can only be designed for a very narrow speed range. One can, in rare cases, take advantage of this to quite an extreme degree if the speed is always constant over a particular curve, as will be appreciated in the case of the "big rides" at theme parks. Even then the cant angle does not really become 360 deg. as might be thought at first sight when the car barrel rolls. Most railways, however, do not have the luxury of all trains travelling at the same speed.

Many years ago I recall the quite appreciable effort needed to climb across the compartment of a stationary train in Penrith Station, where the track had a particularly large cant. The maximum super-elevation used is normally about 6 in., which gives a gradient of 1 in 9½, corresponding to an angle of 6 deg. The big problem really arises when track that is canted for high-speed passenger trains also carries slow freight trains with high axle-loadings. Their flanges grind on the inner rail, and the rate of track wear is prohibitive. In an article such as this it is not possible to go into the complexities of bogie design, but the Technical Centre was able to develop one that would enable vehicles to traverse existing curves at




*Comparison between the active tilting of the BR APT-P (top) and the passive tilting of the JNR class "381" 3 ft. 6 in.-gauge e.m.us*

speeds 20-40 per cent. faster than conventional ones could without the flanges riding against the outer rail.

So, thanks to this development work, there was the opportunity to build trains that would go round curves a lot faster than before. What would be the effect on passenger comfort? One only has to consider what a person in a car experiences if it is driven faster than usual round corners to appreciate that there is a limit to the effect that speed can be allowed to have on passenger comfort. One of the advantages of train travel is that one can carry out many of one's normal home activities inside the confines of the vehicle, oblivious of the fact one is moving at all, let alone being whisked along at speeds that are far faster than those even permitted on motorways. The answer to this problem is to tilt the coach further over than the wheels, so the track and the passengers each experience their own optimum degree of cant.

The idea of tilting trains has been extensively investigated by many railways throughout the world, but, in the main, they have been of the passive rather than active design. In simple terms a passive tilter acts like a pendulum hung from a point above the centre of gravity, so that it tilts when the bottom swings out on the curves. An active tilter, on the other hand, employs a hydraulic or pneumatic system to tilt the vehicle, activated by suitable sensors. In either case the cross-section of the vehicle has to be reduced compared with conventional ones using the same route in order to keep it within the loading gauge. The effect is greater too the larger the degree of tilt for which the train is designed.

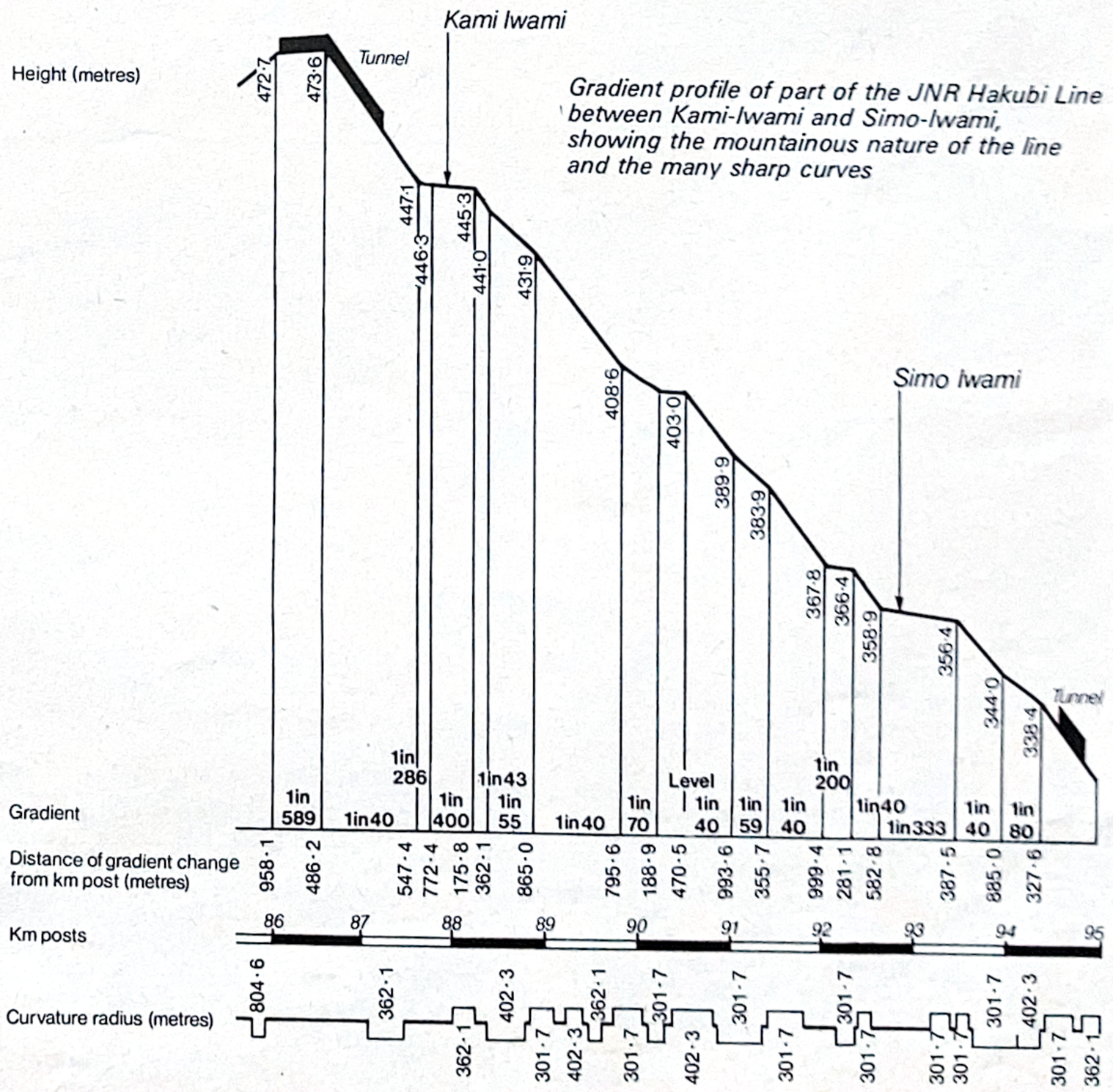
On the APT, which has a maximum tilt angle of 9 deg. compared with the 5 deg. for the Japanese e.m.us, the restriction comes above the waist-line, whereas, because passive tilters inevitably swing *out* on curves, it is the lower half of the vehicle that has to be reprofiled in their case. Passive tilters can only react to conditions they are actually experiencing, whereas the "APT-P" was modified to give advanced warning from the sensors one bogie ahead, thus facilitating the transitions, especially over reverse curves. As I recorded in my February 1982 article, I frequently found the tilt operation undetectable on the inaugural run when I was not watching for it.

Unless the mechanism on a passive tilter actually jams, the coach cannot tilt the wrong way and thus potentially come into contact with another train or a fixed structure. On the other hand, because the APT's centre of gravity is above the tilting centre, its vehicles could potentially swing the wrong way on curves. The daily press has made great play of this possibility, and I have no idea how serious it is or how it arose. As operators of main-line steam locomotives know, clearances these days can change quite appreciably when track improvements are made.

Another important factor for high-speed transport is lightness. Not only does this reduce the overall energy costs, but reducing the weight of the vehicle may be the only way in which sufficient power can be installed within the limitations of the loading gauge. (The Western Region's philosophy with the diesel-hydraulics showed the same approach, with a class "42" "Warship" having greater power than a class "40", and turning the scales at 55 tons less—the equivalent of nearly two MkI coaches.)

One of the easiest ways of saving weight with rolling stock is to use articulation. Even when coal was only £1 per ton between the world wars, the GWR and LNER were both exponents of this principle. However, in spite of using well-developed designs of coach and bogie, an unsplittable combination of several vehicles significantly increases the chances of the operators suddenly being faced with the need to provide a replacement set. So, although Gresley's "Quad-Art" suburban sets soldiered on for many years at relatively modest speeds, his famous quintruplet dining/kitchen car combination was never extensively propagated. When, however, as with the "APT-P", the bogie design is new and needs extensive development under normal running conditions, minor troubles on one of the cars put the whole six-car rake out of action. It is thus not surprising that the next generation of APT will see a reversion to single vehicles.

The "APT-P" was originally designed for a service speed of 150 m.p.h., and, as it attained 160 on trial, this was achieved. Unfortunately it was discovered that power collection at these speeds presented problems. Two power cars were needed to give the necessary output, and it became apparent that the catenary was unstable if two pantographs of the ordinary type were used at high speeds. The only alternative was to put the two power cars together in the centre of the train and connect them together electrically along the roofs. Our



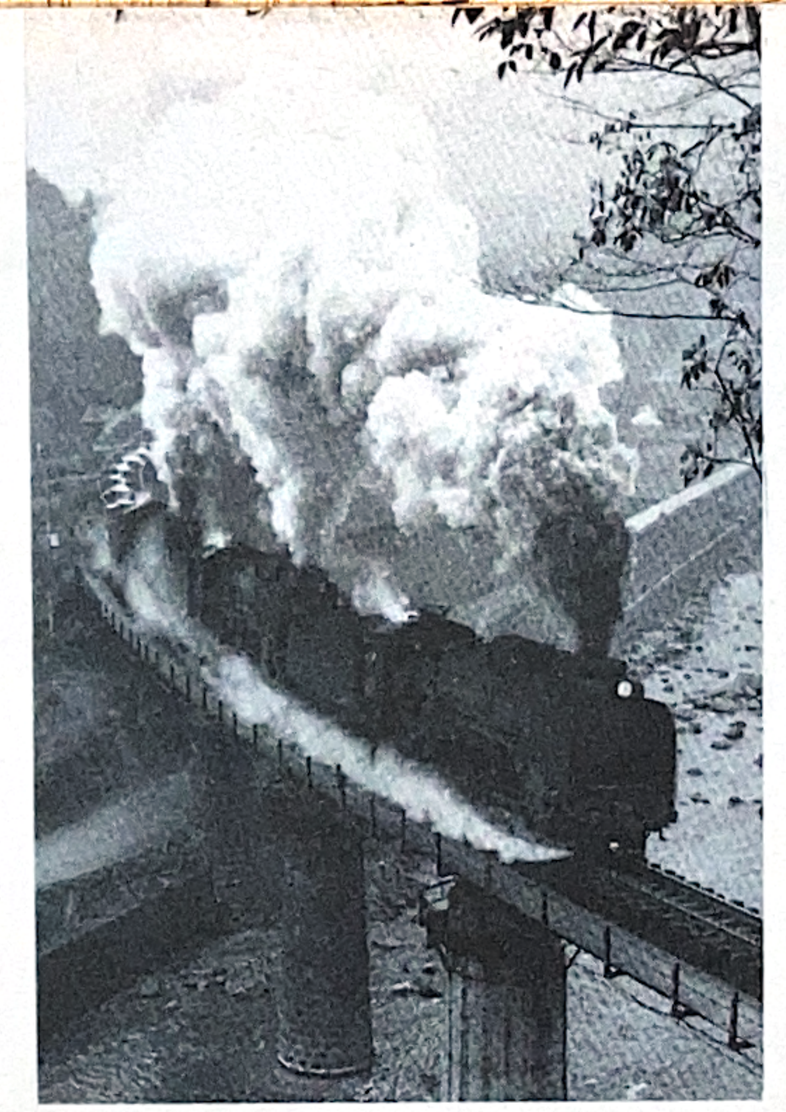

*Gradient profile of part of the JNR Hakubi Line between Kami-Iwami and Simo-Iwami, showing the mountainous nature of the line and the many sharp curves*

designers may have been misled by the Japanese Shinkansen units with their eight pantographs, but is is clear that this was one of the problems that the oriental pioneers had sorted out successfully, and perhaps the significance of their catenary and pantograph designs had not been appreciated. It was certainly purpose-built to deal with multiple pantographs at speeds of up to 130 m.p.h., whereas British overhead electrification had been carried out with single locomotives and low-speed e.m.u. sets in mind. As the "APT-P" power cars were not designed as places where passengers should be allowed to linger, we moved into the somewhat ridiculous situation that the "P" trains had their various facilities duplicated on each side of the pair of central power cars, but this was clearly only a temporary expedient.

The start of regular 125 m.p.h. running on BR with HSTs confirmed the popular appeal of high speeds, and at the same time the excellent ride given by the MkIII coaches was important. In the light of these commercial advantages, it was possible to reassess the likely benefits of 125 versus 150 m.p.h. running between London and Glasgow. It became clear that the extra 25 m.p.h. was not only expensive, but much less cost-effective. The way was then open to reduce the length of the "APT-P" slightly and use only a single power car, which could be at one end and thus obviate the problem of public access through it. However, experience showed that, even with the two power cars in a two-plus-eight formation, wheel-slip could prove a problem, as it did in fact on the early-morning climbs to Beattock and Shap last December. This put the designers back to "Square One", but more recently still Brecknell Willis and BR have come up with a design of pantograph that permits a pair to be used satisfactorily on a train at these speeds. So it now looks as if that particular problem has been solved.

The French with the TGV had the same thing to cope with, and got round it by taking a 25 kV power line along the roof the length of the train. It would certainly need a lot of pleading with the Department of Transport Inspectorate to permit that in this country, and I suspect loading-gauge differences are also significant (the roof of an "APT-P" power-car is, for instance, more than 6 in. lower than one of the passenger vehicles). As far as I am aware, the fact that the APT tilts has no bearing on this power-line problem.

The braking system needed for high-speed running is even more vital than the provision of power to achieve the speeds. The energy to be dissipated increases with the weight involved and with the square of the speed. This involves an extra 44 per cent. at 150 m.p.h. compared with 125. In order to provide a sufficiently large heat sink, the hydrokinetic brake was developed for the APT, which permitted the resulting reservoir of hot water to be cooled again with radiators over the whole period occupied by the next acceleration to full speed. If, however, speed is limited to 125 m.p.h., the HST disc brakes are perfectly satisfactory (apart perhaps from the smell). Disc technology generally has improved since the APT was designed,



*A triple-headed "merry-go-round" train of limestone on the Hakubi Line in steam days, with three "D51" class 2-8-2s crossing a bridge over the River Takahashi, between Niimi and Bitchu-Kojiro, on a gradient of 1 in 40. Photo: courtesy JNR*

and is now probably capable of dealing with speeds of up to 140 m.p.h. This means that the next generation of APTs can do without the complications of hydrokinetic brakes, which must be provided with a mechanical system for use at the bottom end of the speed-range anyway. By all accounts the design of the latter has been unsatisfactory and resulted in brakes dragging at times, with the resulting dangers that would ensue from that if it continued undetected.

Because tilting is purely for comfort, there is in theory no need for the non-passenger carrying cars to be equipped with this facility. It is one of the minor mysteries, therefore, that the power cars on the "APT-P" were designed to tilt. Not only does it complicate the design of the pantograph which clearly had to retain its position relative to the overhead wires, but, with the traction motors and their hydrokinetic brakes housed in the body, the power transmission also had to contend with the changing geometry. It would seem therefore that the next generation of APTs could see non-tilting power cars, or, if they are passenger-carrying, it may be that, without the need for hydrokinetic brakes, the traction motors can be bogie-mounted, although that possibility at present apparently is not on the drawing board.

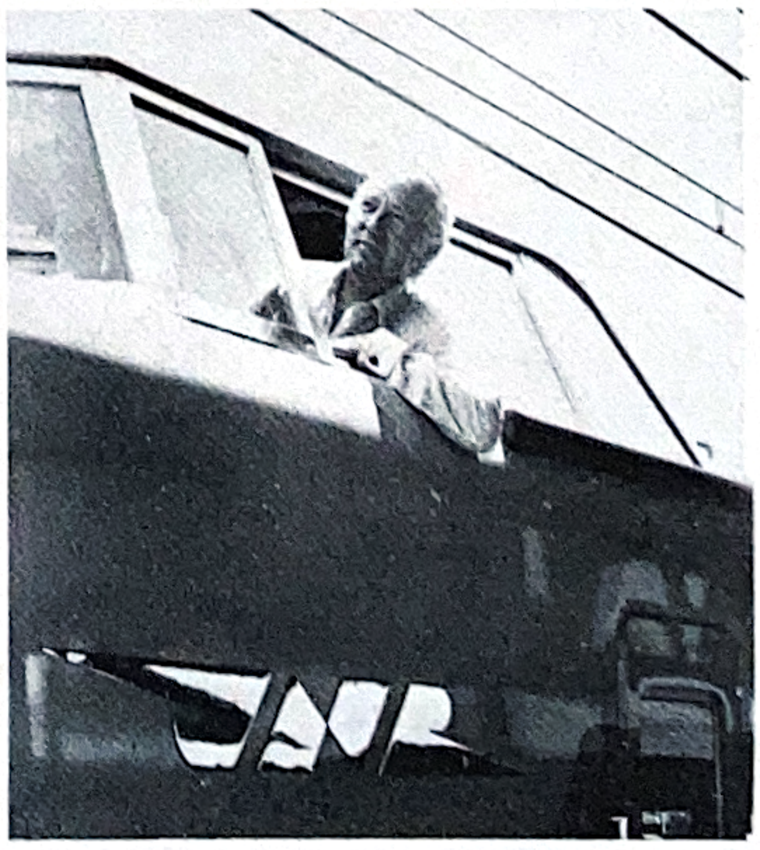
This has not been a chronological account of the APT development, but has nevertheless, I hope, provided an indication of the technical problems involved with the more-important design features of the train, and how the constraints with which they have been made have changed over the years. At the time of the December 1981 introduction, the APT project had cost £37·3m. This may seem a lot of money, but it is less by a factor of 10 compared with the development costs for a new car. The suffix "P" in "APT-P", after all, does mean Prototype, and the units are far further removed from the "E" train than the service HSTs were from their prototype (which did not see much public service either). Prototype air liners do not as a rule get sold to the airlines, while, when I was in Vienna in April 1982, the prototypes of the city's U-Bahn e.m.us was being *completely* rebuilt (right down to the electric wiring) at Simmering-Graz-Pauker to conform to the subsequent production units.

One final question that frequently gets asked is whether there was any justification to try and get the unit into service in December 1981. With any project of this sort where there is a protracted development period, it is no bad thing for the team's motivation to inject target dates into the programme. If senior people are taking a special interest too, extra resources that are badly wanted may then become available, particularly in difficult times all round.

Before leaving the British scene to describe the Japanese tilting trains, I must comment on the one great advance that has resulted from the ATP programme—the HST! When the ideas for the revolutionary tilting trains were being put forward, BRB felt that the proposed time-scale for their introduction was too optimistic. They therefore looked around for an alternative capable of quicker development, and, one suspects, the CM&EE people at Derby jumped at the opportunity of showing what could be done by stretching conventional technology. The result was the HST. The overwhelming technical and commercial success of these units is there for everyone to see, and next month I plan to discuss their performance over yet more new routes such as the Midland main line to St. Pancras. We must thus be thankful for the spur to their development that was provided by the APT, and at the same time look forward to the latter's reincarnation in a simplified form in the future.

July 1, 1982, was a great day for the railwaymen of the Yonago Division of Japanese National Railways, as that

*The Author looking out of the raised cab of JNR tilting e.m.u. No. 381-137 at Yonago on August 7, 1982, the occasion of the run described in this article. Photo: courtesy Mainichi Shimbun*



*month's* issue of the JNR all-line timetable showed the start of the new electric service over the 138-mile 3 ft. 6 in.-gauge Hakubi Line from Izumo to Okayama. For the initial 40 miles the route lies along the northern coastal plain, but then turns inland to climb over the mountains that run the length of Honshu. A comparable British route might be Perth to Dingwall, but, whereas the climb from Perth to Druimachdar lifts the line nearly 1,480 feet in 53 miles, the Hakubi line climbs 1,530 feet in only 33 miles. The ruling gradient is 1 in 40 and there is a constant succession of reverse curves, with radii as little as 300 metres. In the steam days the line was noted for its triple-headed merry-go-round limestone trains shown in one of the illustrations. It is in conditions such as this that JNR now uses its tilting e.m.us, and they are allowed to run up to 20 km/hr (about 12 m.p.h.) faster over these curves if the track is strong enough. This is 30 per cent. faster than normal trains are allowed, and the passive tilting arrangements improve passenger comfort.

My wife and I were seen aboard the 11.22 from Matsue with the usual salutes from the stationmaster, and as far as Yonago I travelled in the train. In addition to the new car sheds to the west of Izumo, there have been other extensive civil-engineering works connected with electrification, including remodelled stations and realignments. Some of them were still causing speed restrictions over this initial stretch, part of which is single line. As a result, the first 17·9 miles took nearly 28 min., at an average of under 40 m.p.h., as will be seen from Table I.

*Driver Sumi, of Yonago Depot, at the controls of tilting e.m.u. No. 381-137 on August 7, 1982. Photo: P. W. B. Semmens*

At Yonago I transferred to the cab where I joined Driver Sumi of that depot, as well as Mr. Hamano, the Divisional Traffic Superintendent, who told me about his visit to the National Railway Museum at York a few years earlier. An inspector was also present in addition to Mr. Niinobe, my guide from the JNR Overseas Department.

The cab is perched well up in the nose, like the "Bullet Trains", and after everyone had climbed-up, a bench seat was folded out across the stair-well to supplement the normal pair of seats on the two sides of the cab. Being given the seat of honour on the right, I could not watch the position of the controls too easily, although the tachometer was handy just in front of me.

There was an initial delay as the air-conditioning was faulty in one of the cars, and fitters were trying to clear the trouble, using the unit's internal telephones to discuss the matter. So we got away 9¾ min. late and is was clear that Driver Sumi was anxious to recover as much of this as possible. As far as Hoki Daisen the line is double, and we reached 65 before slowing to 19 to take the right-hand line at the junction on to the single track over the mountains. The line speed had gone up to 68 m.p.h. with the introduction of the new units, an increase of 10 m.p.h., but the sharper curves and the frequent crossing loops tended to limit our opportunities to take advantage of it. There were indeed nine of them to negotiate on the climb to the summit, one of them—Kami-Mizoguchi—being what the Japanese refer to as a Signal Station. This loop is better than most, as we were able to run straight through at 43 m.p.h. on the ascent, whereas there were usually far more severe restrictions elsewhere, as will be seen from the table.

The units consist of three-car sets, some of which have driving positions at one end, and are customarily made up into nine-car trains. Each set comprises a pair of motor cars having a common control system for their eight 160-horsepower motors, and a trailer. The tare weight came to 336 tons, and, as it was virtually full, the gross weight was some 375 tons. This gave us a loaded power/weight ratio of 10·2 h.p. per ton.

Gradients of 1 in 68 start appearing after Kishimoto and, when they progressively steepen to 1 in 40 towards the summit south of Kami-Iwami, so the curvature increases. As will be seen from the diagram, over the three miles leading up to this station there is only three-eighths of a mile of straight track, the curves all having a radius in the range 300-400 metres. M. Hiyoshi, the Chief of the JNR Operation Planning Division, has provided me with graphs showing how these units can traverse curves faster than ordinary stock, and the time-saving is quite marked. Up the 1 in 40 after the p.w.s. beyond Shoyama we accelerated from 35 to 43 m.p.h. in a kilometre, and cleared the second at 50, but the gradient had eased to 1 in 80 just before the kilometre post. Depending on the curvature, therefore, the units would appear to be capable of attaining 45-50 m.p.h. on a continuous gradient of 1 in 40. The crew drew my attention to the fact that the catenary voltage was down to 1,350 from

**TABLE I. JAPANESE NATIONAL RAILWAYS: HAKUBI LINE MATSUE - KURASHIKI**

| | | | |
|---|---|---|---|
| Date: | | August 7, 1982 | |
| Formation (cars): | | 9 | |
| Motor/trailers: | | 6 + 3 | |
| Weights: empty/full (tons) | | 336/375 | |
| Dist. | | Actual | Speeds |
| Miles | | m.s. | m.p.h. |
| 0·0 | MATSUE | 0 00 | — |
| 4·2 | Higashi - Matsue | 5 12 | 65/—* |
| 6·0 | Iya | 7 32 | — |
| — | | p.w.s. | 30* |
| 12·5 | Yasugi | 17 13 | 29*/57 |
| 17·9 | YONAGO | 27 49 | — |
| 3·0 | Hoki - Daisen | 3 45 | 65/19* |
| 6·8 | Kishimoto | 7 52 | 62/43* |
| 9·9 | Hoki - Mizoguchi | 11 10 | 62/31* |
| 13·0 | *Kami - Mizoguchi* | — | 47* |
| 15·6 | Ebi | 17·50 | 31* |
| 16·9 | Muko | 19 31 | — |
| 19·8 | Neu | 23 01 | 28* |
| 24·5 | Kurosaka | 28 46 | 62/— |
| 27·5 | Kamisuge | 32 34 | 62/36* |
| 29·7 | Shoyama | 35 42 | 50/35* |
| — | | p.w.s. | 35*/50 |
| 35·1 | Kami - Iwami | 43 44 | — |
| 2·4 | Niizato | 3 39 | —/31* |
| 6·0 | Ashidachi | 8 04 | — |
| 9·9 | Bitchu - Kojiro | 13 11 | — |
| 11·4 | *Nunohara* | 15 40 | — |
| — | | p.w.s. | —/22* |
| 13·5 | NIIMI | 20 05 | — |
| — | | p.w.s. | 25* |
| 6·5 | Ikura | 7 55 | — |
| 11·3 | Hokoku | 14 51 | — |
| 14·2 | Bitchu - Kawamo | 18 47 | — |
| 16·6 | Kinojama | 22 22 | — |
| — | | p.w.s. | —/25* |
| 19·6 | Bitchu - Takahashi | 27 07 | — |
| 2·7 | Bitchu - Hirose | 3 07 | 56 |
| 7·0 | Funagi | 7 58 | 56 |
| 9·3 | Hiwa | 10 18 | — |
| 11·6 | Gokei | 12 32 | — |
| 14·5 | Soja | 15 38 | 59 |
| — | | stop | — |
| 21·1 | KURASHIKI | 24 23 | — |

* *Speed restrictions*

*View from the cab of e.m.u. No. 381-137 as it ran into the passing loop at Kami-Iwami Station, where it crossed a northbound express of similar stock (centre) and a slow train (right). Photo: P. W. B. Semmens*

the normal 1,500 on this bit of the climb. As we ran in to the station at Kami-Iwami, we discovered that we were due to cross a northbound express there as well as a slow train, and their power demands on the climb to the summit had clearly combined with ours to drop the voltage.

The summit tunnel starts a kilometre south of Kami-Iwami, and the initial stages of the descent are very similar to the climb, with the road, railway and river twisting together down the narrow valley, the walls of which are frequently reinforced to prevent landslides. These conditions enabled Driver Sumi to give us an excellent demonstration of his skill with the 17-notch dynamic brake. Thanks also to the fast climb, by the time we reached Niimi we had managed to recover 7¾ min. of our late start, in spite of our accelerated schedule. It is at this point that the gradients generally start easing out as the southern coastal plain is approached. I left the cab here, and went back to my seat in the "Green Car" in the middle of the train.

Over the next section to Bitchu-Takahashi we only just managed to keep time, but shortly after that point the line becomes double-track and we were able to indulge in some fairly sustained speeds in the upper 50s. Shortly before Kurashiki the brakes suddenly went on hard, and we ground to an emergency stop. The driver announced over the public-address system that this was due to a cyclist crossing the line, and it is worth remarking at this point that ordinary Japanese trains are required *by law* to be able to stop within 600 metres (660 yd.) at any time. Having missed the cyclist, we got away again in 19 sec. and reached Kurashiki a minute-and-a-half late, at the end of an excellent example of the capabilities of these units. In spite of the emergency stop we averaged 51·9 m.p.h. over the 21·1 miles from Bitchu-Takahashi to Kurashiki. The east-west Sanyo Line is joined here for the final stage to Okayama, but we alighted at this point to see the museums and other places of interest in this ancient city.

As with the inaugural APT run, it is difficult to compare the effect of the tilt on passenger comfort, for the very good reason that in neither case have I ever been over the same route in a conventional vehicle at comparable speeds. The operation of the tilt system is shown in Figure 1, and I had already seen the demonstration rig in the Modern Transportation Museum in Osaka. Although the V-shaped windscreen in the cab gave me no vertical reference points to note the tilt, I could feel the movement taking place in two stages as we went into and out of the curves. This effect was not apparent in the coach half-way back along the train, and may be due to the interaction between the vehicles which cannot exist at the very front of the train.

The conventional class "481/4/5" e.m.us have a steadying cross-connection between adjacent vehicles above the vestibule, but I did not notice whether their tilting counterparts were similarly so equipped, which could explain the effect. I got the impression that nausea is not entirely absent with all passengers on the Japanese tilting trains—as is also the case on the APT. Having read of similar instances on the non-tilting TGVs in France, it is clear that the whole matter is a complex physiological one, and clearly lies outside the remit of this series!

My grateful thanks are due again to the British and Japanese railway authorities for the opportunities I have had on behalf of *The Railway Magazine* readers to observe the performance of these interesting new trains.

*Passengers relaxing in the "Green Car" of tilting e.m.u. No. 381-137; thanks to the tilting, no luggage fell from the racks! Photo: P. W. B. Semmens*

*From "The Railway Magazine" of January 1933*

THERE can be little dispute that the year 1932 has been one of the most noteworthy, from the locomotive performance point of view, within the experience even of the oldest of readers. Relatively, the greatest of advances have been made upon the London Midland & Scottish and London & North Eastern systems, *pari passu* with the striking improvements in the main-line schedules of those companies. Timings which one had good reason to regard as daring, when they first appeared on paper, have proved perfectly practical, as these columns have borne witness. Engines have revealed totally unsuspected powers of speed and haulage . . . .

* * *

MR. ERIC GILL, the famous sculptor, recently fixed a name board to the front of the "Flying Scotsman" express at Kings Cross. The type face known as "Gill Sans", designed by him, has been adopted as the LNER standard for every form of lettering and printing, and represents, perhaps, the greatest standardisation of a type face by a large industrial undertaking during recent years.

* * *

LNER three-cylinder 4-4-0 engines Nos. 336 and 352, previously named *Buckinghamshire* and *Leicestershire*, have been renamed *The Quorn* and *Meynell* respectively. The two locomotives are fitted with rotary cam poppet-valve gear, and have been transferred from the "Shire" to the "Hunt" class, as the latter are all similarly equipped, and uniformity has thus been obtained.

* * *

ON the "Sunny South Express" workings of the LMS and Southern Railways the earlier practice has been reverted to of employing the rolling stock of both companies alternately, though LMSR restaurant cars are used in both directions. In this connection a curious happening was noticed at Clapham Junction on August Bank Holiday when SR No. 773, *Sir Lavaine*, came through on an up Bournemouth express with a 16-coach corridor formation which included, next to the engine, six LMSR vehicles. Comprised in this maroon "set" was a dining car of Midland clerestory type; the reversal of the roof boards prevented indentification of the coaches, but they probably were the relief set for the "Pines Express" working, borrowed for the occasion.

* * *

ON October 31 the GWR passenger train services between Wolverhampton, Tettenhall and Stourbridge Junction (via Wombourn) were withdrawn. Tettenhall, Himley and Wombourn stations remain open dealing with parcels, livestock, merchandise and minerals.

* * *

REFERENCE was made in our columns recently to the working of one of the LMSR Beyer Garratt 2-6-0+0-6-2 locomotives on a train of passenger stock. Mr. J. H. Woolley writes in this connection to say that the original three engines of this type — Nos. 4997-9 — were fitted with the vacuum brake at the time of construction, whereas the remainder of the series are not so fitted. In the early years of the first three, Mr. Woolley observed one of them at work on the "Thames - Forth Express" on the heavily-graded section between Chesterfield and Sheffield.

* * *

SEVERAL correspondents write to mention the appearance of "Castle" class GWR express locomotives on local services round Birmingham, more especially on the 11.30 a.m. from Moor Street to Henley-in-Arden, returning to Birmingham on the 1.32 p.m. train. So far as we can ascertain, these are merely examples (as recently referred to in these columns in connection with the LNER) of engines filling in time between their more appropriate spells of main-line duty, so enabling economies in engine power to be effected.

* * *

SOUTHERN RAILWAY Adams 7-ft. 4-4-0 locomotive No. 577, class "X2", was observed in Waterloo Station, on a train of empty stock, quite recently. This is the oldest engine of the class, having been built in 1890, and is one of the last to remain in service. The first of the class to go, No. 595, was scrapped at Eastleigh in December 1930, and the majority have since followed her.

* * *

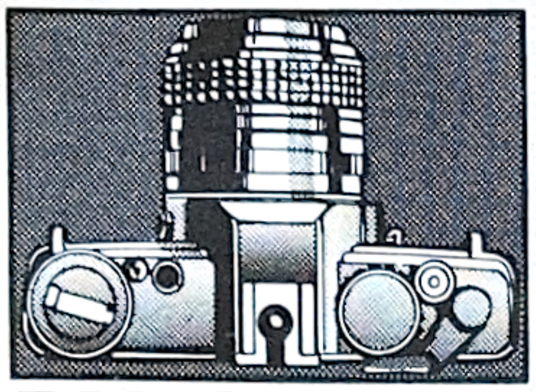
IT is interesting to observe how many different classes of locomotive have, at various times, been dignified with the nickname of "pugs". These were nearly always engines of the dock shunter variety, but at Blair Atholl shed the large Highland 0-6-4T banking engines used between that station and Dalwhinnie used also to be known as "pugs", at least by some of the footplatemen.

* * *

A NEW LMSR station, to be called Upminster West, situated at Hornchurch Road bridge, between Hornchurch and Upminster, is to be built. The station, which will be served by electric trains, will cater for the rapid residential development which is going on in the vicinity.

* * *

AN enthusiastic friend once said of the Bishops Castle Railway that it was worth going all round the world to see; and though some might dispute so strong a claim, it does certainly well repay a visit. From Bishops Castle Junction, three-quarters of a mile north of Craven Arms & Stokesay, on the Shewsbury & Hereford Joint line, this independent standard-gauge railway runs for 10½ miles, first up a narrow and picturesque winding valley and then in more open country to the town of Bishops Castle, on the borders of Shropshire and Montgomery, reversing at Lydham Heath, 2½ miles from the terminus. The line has long been in the hands of an official receiver, and appears to be in the last stages of decay. So rusted and grass-grown is the track that one would think that no train had passed over it for years: in places trees all but form a green roof overhead and frequently brush against the sides of the carriages. [In fact, the BCR struggled on until April 1935.]



PANORAMA

# Fresh Freight to North Wales

*First class "56" to reach Llandudno Junction (top), on September 28, No. 56 085 hauls a train of hopper wagons, then running twice daily (see "RM" December, page 546), conveying pulverised fly ash from Fiddlers Ferry Power Station, Merseyside, for the A55 road project. A new private siding has been established nearby for delivery of 800,000 tonnes of landfill. Present in the yard is locomotive 40 197; and a d.m.u. waits to leave for Chester—minus windows damaged in a severe gale along the Conway Valley branch the previous day*

*Nos. 40 035, "Apapa", and 40 194 on arrival at Penmaenmawr (bottom) on September 24 double-heading a train of 26 "PGA" wagons from Hope Street Stone Terminal, Manchester. Photos: Ron Watson Jones*